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(54) Protecture container for the underground installation of tanks for pressurized, liquefied gas

(57) An improved fluid-tight, openable, protective container (1, 2, 3, 4) for the underground installation of a tank of pressurized, liquefied gas (14) with the formation of an interspace (17) between the container and the tank housed therein, in which the container has a top (3) which has a hatch (4) and is fixed removably to a peripheral wall (1) and which forms, with a connecting collar (12) of the hatch (4), a semitoroidal housing for a sealing ring (13) for separating the interspace (17) from a space inside the hatch (4), the semitoroidal housing having an outer edge (18) for bearing on the tank (14) to ensure a predetermined compression of the seal (13), an opening of predetermined depth (H1) between an inner edge (20) of the housing and the tank (14), and differentiated sealing by the seal (13) under excess pressures according to whether these develop in the interspace (17) or in the space inside the hatch (4).

The outer edge (18) has at least one radial channel which enables inspection probes to be introduced into the interspace from the hatch simply by the removal of the seal (13), without the need to remove the top (3).

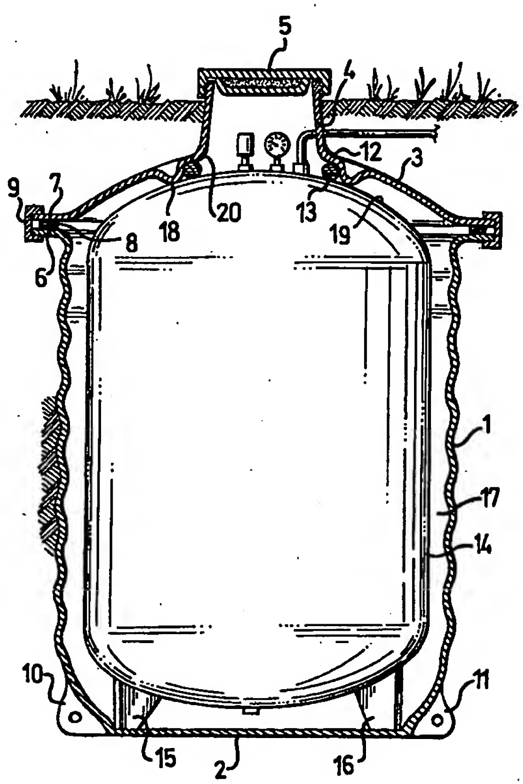

FIG.1

Description

The present invention relates to an improved, openable, protective container for the underground installation of a tank for pressurized, liquefied gas.

The Applicant's published European patent application EP-0624752 describes a protective container of plastics material, comprising a vessel having a generally cylindrical peripheral wall with a vertical axis closed at the bottom by a base and at the top by a removable top with a hatch closed by a cover.

The container houses a tank of pressurized, liquefied gas with the formation of an interspace which, when the container is buried, contains any gas leakages, isolates the tank from the surrounding soil and protects it against corrosion brought about by the acidity and dampness of the ground and from stray currents.

The container is installed completely underground except for the hatch cover which is left accessible for the opening of the hatch which is necessary for periodic filling of the tank.

Whereas the fluid-tight container provides excellent protection for the tank, neither internal nor external corrosion can be completely excluded because of impurities which accumulate on the bottom of the tank and because of transportation mechanisms caused by repeated cycles of condensation and evaporation of the atmospheric moisture in the interspace at various points on the outer surface of the tank. These condensation cycles are caused by local temperature variations resulting from the evaporation of the liquefied gas which is generally drawn off at flow rates which vary greatly over time, even though a seal interposed between the tank and a hatch collar isolates the interspace from the space inside the hatch and prevents exchange of the air in the interspace and the entry of moisture.

For this reason, it is necessary to check the tank periodically, at least every ten years and preferably more frequently, and hence partially to excavate the installation in order to expose the top and the hatch and to remove the top and allow the tank to be removed from the container and thoroughly inspected.

Although the excavation is limited, it still constitutes a considerable task and the checking operation involves the system being rendered inactive for quite a long period of the order of a few days.

It is therefore desirable to provide an openable protective container which allows the tank to be inspected at least partially, particularly in its lower portion which is most exposed to risks of corrosion, through the hatch alone, without even partial excavation and opening of the container.

This inspection can provide useful indications for deferring the full checking operation or, when necessary, for putting into effect preventive and maintenance operations for the improved efficiency and maximum safety of the installation.

A further problem is constituted by the fact that the seal separating the interspace from the hatch space has to ensure fluid-tightness at different pressures according to whether there is excess pressure in the gap compared with the hatch space or excess pressure in the hatch portion compared with the interspace.

In the first case, which may be caused by gas leakages from the tank, the seal has to yield at a predetermined excess pressure and allow the excess pressure to be discharged easily into the hatch space, possibly even causing its cover to open.

In the second case, which may be caused by leakages of gas from the connecting, shut-off and measuring assemblies housed in the hatch, the seal has to ensure perfect fluid-tightness and prevent any infiltration of gas into the interspace, the discharge of the excess pressure in the hatch space being entrusted simply to the forced opening of the hatch cover brought about by the excess pressure.

It is therefore necessary to provide a seal housing advantageously shaped to permit this differentiated behaviour, but this is not enough.

In order the behaviour of the seal to be repetitive, the compression force exerted on the seal has to have a predetermined value regardless of the dimensional tolerances of the elements clamping the seal and of the variable load (according to the installation, the nature of the ground and its moisture content) exerted by the earth covering the top.

These requirements are satisfied by the improved, fluid-tight, protective container of the present invention in which the top of the container forms, with a connecting collar between the hatch and the top, a semitoroidal housing for a toroidal seal or O-ring with a cross-sectional diameter advantageously larger than 30 mm and preferably between 30 and 40 mm.

An outer, larger-diameter edge of the housing bears on the upper cap of the tank whilst the other, inner edge is spaced from the upper cap of the tank and is connected to the hatch in a manner such as to form a calibrated opening between the hatch and the cap of the tank for the expulsion of the seal towards the hatch space in the event of pressure in excess of a predetermined value in the interspace.

According to another aspect of the present invention, the outer edge of the semi-toroidal housing is interrupted radially at at least one point, but preferably at a plurality of points spaced evenly around its circumference, by a radial channel forming a through hole of suitable depth and width, which is normally closed by the seal and which puts the interspace formed between the container and the tank into communication with the space inside the hatch and allows an inspection probe, probes for draining condensation or for the admission of protective liquids, or other maintenance probes to be introduced into the interspace.

This achieves the dual effect of ensuring controlled compression of the seal and of affording access to the interspace for inspection and/or maintenance means simply by the removal of the seal, possibly only locally.

These means may consist of a miniaturized optical,

magnetic, acoustic or combined inspection probe for checking at least one cylindrical arc of the tank surface and one sector of its lower closure cap which is most exposed to risks of corrosion.

Even without a full check of the tank, this partial inspection provides useful indications of the state of the tank and of its integrity and enables full checking operations with excavation and removal of the tank from the container to be deferred and spaced out over time.

Moreover, a probe for drawing off any condensation liquid which has accumulated or even a pipe for the admission of antifreeze liquid can also be introduced through the radial channel as far as the base of the container.

Furthermore, by the provision of a plurality of radial channels which extend through the outer edge of the seal housing, the inspection by probe can be extended to practically the entire outer surface of the tank and the entire internal surface of the container.

The characteristics and advantages of the invention will become clearer from the following description of a preferred embodiment and from the appended drawings, in which:

Figure 1 is an overall view, in vertical diametral section, of the underground installation of an improved protective container for a tank for pressurized, liquefied gas, according to the present invention,

Figure 2 is a perspective view of a preferred embodiment of the top and the hatch of the protective container of Figure 1,

Figure 3 is a section taken on the line I-I of Figure 2, on an enlarged scale, showing a portion of the top and the hatch of Figure 2 and its relationship with a sealing ring and with the tank of pressurized, liquefied gas,

Figure 4 is a section taken on the line II-II of Figure 2, on an enlarged scale, showing a portion of the top and the hatch of Figure 2 and its relationship with a sealing ring and with the tank of pressurized, liquefied gas,

Figure 5 is a section taken on the line III-III of Figure 4, on an enlarged scale, showing a portion of the top shown in Figure 4 and its relationship with a sealing ring and with the tank of pressurized, liquefied gas,

Figure 6 is a perspective view of a variant of the top and the hatch of the protective container of Figure 1.

With reference to Figure 1, an improved openable container according to the present invention comprises a generally cylindrical vessel formed by a peripheral wall 1, a base 2 connected to the peripheral wall 2, and a top 3 with a hatch 4 closed by a cover 5 screwed or engaged like a bayonet on the hatch 4.

The peripheral wall 1 has bellows-like toroidal corrugations of suitable depth which increase its rigidity and resistance to radial deformation relative to the axis of the cylinder of the vessel and give the wall advantageous axial resilience.

The upper edge of the peripheral wall is bent outwardly to form a flange 6 for fluid-tight coupling with the peripheral edge of the top 3, which is also bent to form a coupling flange 7.

A resilient sealing ring 8, preferably but not necessarily of rectangular cross-section, is interposed between the two flanges 6, 7.

A releasable tie 9 or other equivalent clamping means clamps the two flanges releasably, exerting a suitable pressure on the seal which hermetically seals the joint.

The base 2 has external eye bolts 10, 11 for lifting and for the anchorage of a ballast plate, not shown.

The top 3, which is generally in the form of a spherical or conical dome, is connected to the hatch 4 by means of a semi-toroidal collar 12 forming a housing for a sealing ring or O-ring 13 of circular cross-section.

The container houses a cylindrical tank 14 for pressurized, liquefied gas, disposed with its axis vertical and having feet 15, 16 for resting on the base 2, the tank preferably being spaced from the base 2, from the peripheral wall 1, and from the top 3 so that an interspace 17 is formed between the walls of the container and the tank.

The sealing ring 13 interposed between the collar 12 and the tank 14 isolates the gap from the space inside the hatch 4 and prevents the infiltration from the hatch towards the interspace of liquid or gaseous fluids and solid foreign bodies, such as dust, soil, etc., which could accidentally fall from the hatch when it is opened.

The interspace advantageously has a minimum width of the order of 4-8 cm except near the upper cap of the tank where the top 3 is bent inwardly to contact the upper cap of the tank and is then connected to the collar 12 to form a semi-toroidal housing for the positioning and outer abutment of the seal 13.

The seal, which is preferably of synthetic neoprene rubber, advantageously has a circular cross-section with a diameter of the order of 3-4 cm to provide suitable resilience and compressibility which ensure fluid-tightness.

As can be seen more clearly from the section of Figure 3, the semi-toroidal seal housing formed by the collar 12 has an outer edge 18 which is in contact with the upper cap 19 of the metal tank and an inner edge 20 connected to the hatch and spaced from the cap 19.

The maximum depth H of the semi-toroidal housing relative to the bearing surface is advantageously less than the diameter D of the cross-section of the seal so that D-H=C represents the compressive deformation applied to the seal, which corresponds univocally to a predetermined compression force exerted on the seal

13.

This force is completely independent of the load exerted on the top 3 by the overlying soil, the weight of which is discharged, on the one hand, to the peripheral wall of the container (by means of the releasable joint of the flange 7, the seal 8 and the flange 6 of Figure 1) and, on the other hand, to the upper cap 19 of the tank by means of the edge 18 of the semi-toroidal housing.

It is also independent of the resilient stresses to which the top 3 is subject and of the corresponding reaction exerted by the cap 19 which develop as a result of the clamping of the flanges 6,7, an operation which must jointly ensure a predetermined precompression of the seal 8 (even in the absence of overlying soil) and contact between the outer edge 18 of the collar 12 and the upper cap 19 of the tank 14.

In fact, it is clear that, whereas the precompression of the seal 8 can be controlled precisely and is determined exclusively by the clamping tie 9 (or by equivalent means such as bolts), the stresses which develop between the edge 18 and the cap 19 are greatly influenced by the dimensional tolerances of the container and the tank housed therein.

These behave like a structure formed by a rigid body (the metal tank) compressed between two opposed relatively resilient plates which are subject to bending stresses (the base and the top of the container) and which are coupled by a relatively resilient element which is subject to tensile stress (the peripheral wall of the container).

Any variation in the axial dimensions of the tank and of the container from a nominal design dimension involves a resilient deformation of the container other than the designed deformation and hence involves different resilient reactions.

The compression C=D-H is completely independent of these variables and depends solely upon the geometrical dimensions D and H, the production tolerances of which, relative to a nominal dimension of the order of 30-40 mm, are wholly negligible even when the container is formed by rotational moulding.

It should also be pointed out that the collar 12 behaves, relative to the seal 13, as a rigid element which is not significantly deformed either by the limited load exerted by the overlying soil or by the reaction exerted by the compressed seal, which stresses, incidentally, act in opposite directions and are thus to some extent balanced.

A predetermined contact pressure between the seal 13 and the housing and between the seal and the cap of the tank can thus be ensured with the required repeatability.

The opening H1 between the inner edge 20 of the seal housing and the cap 19 of the tank is advantageously calibrated (equal to or a little less than the maximum depth H of the housing) in a manner such that, for a predetermined excess pressure in the interspace compared with the pressure in the hatch, the seal 13 is expelled from its housing and urged towards the space inside the hatch.

Clearly, however, an excess pressure in the hatch space compared with the pressure in the interspace 17 compresses the seal inside its housing and increases the contact pressure between the seal 13 and the collar 12 on one side and the cap 19 on the other, increasing the sealing effect.

As shown in Figures 2, 4 and 5, the outer edge 18 of the semi-toroidal housing does not extend continuously around the entire collar 12 but is interrupted by at least one radial channel and preferably by a plurality of radial channels, each defined by a saddle 20, 21, 22, 23, 24, 25, 26 formed by the top 3.

The depth H2 of the saddle is advantageously less than the depth H of the semi-toroidal seal housing to ensure an adequate abutment for the seal.

As shown in Figure 5, the channels may have trapezoidal cross-sections with suitable corner connections but may also have semi-circular, rectangular or corrugated cross-sections which, in any case, are such as to ensure a suitable clear channel cross-section of the order of 25-40 mm.

Clearly, the removal of the seal 13, even only locally at the mouth of the channel, thus allows a miniaturized inspection probe with a transverse dimension smaller than the cross-section of the channel to be introduced into the channel.

The probe is pushed as far as the upper edge of the peripheral wall and is then made to descend to the bottom of the container through the interspace 17.

The probe may comprise a miniaturized video camera with solid-state detectors (CCDs or charge-coupled devices), a fibre-optic endoscope, or fault detectors with inductive coupling or ultrasound excitation.

With a probe of this type, it is possible to check the state of a large portion of the side wall of the tank and of sectors of both the upper and lower hemispherical caps and to obtain indications of the state of the tank without the need for excavation, removal of the top 3 or removal of the tank from the container.

Clearly, therefore, with the provision of a plurality of channels defined by the saddles 20, 21, 22, 23, 24, 25, 26 extending radially from the collar 12, as shown in Figure 2, substantially the entire outer surface of the tank 14, as well as the internal surface of the container, can be inspected by the same technique.

In addition to the ability to inspect the tank without the need for excavation, it is also possible to introduce a drain probe into the interspace in order to draw off any condensation water which has accumulated in the vessel and to admit antifreeze liquid and inert liquids with good thermal conductivity to ensure an advantageous flow of vaporized gas. In fact, it should be borne in mind that the withdrawal of gas from the pressurized tank takes place in the gaseous phase and presupposes its evaporation with a consequent cooling effect which, in the absence of heat exchange with the exterior, intrinsically limits further development of the gaseous phase.

In certain situations in which relatively high or

greatly variable flow-rates of gas are required, it is therefore appropriate to ensure a more effective thermal exchange between the tank, the container and the surrounding soil than that ensured by conductive and convective transmission by the air in the interspace and to increase the thermal capacity and hence the thermal inertia of the system.

This can be achieved by the admission of inert liquids with high thermal conductivity and a high specific heat capacity into the interspace but, in order to avoid potential contamination of the liquid, this operation naturally has to be carried after installation, by the removal of the seal 13.

Since the compression force of the seal 13 is controlled and, in the absence of excess pressures in the hatch, has low values, the removal of the seal from its housing is extremely easy and can be carried out with the aid of a lever with a blade of suitable shape inserted between the collar 12 and the seal 13 and pivoted on the inner edge 20 of the housing as a fulcrum.

The foregoing description relates solely to a preferred embodiment but clearly there may be many variants.

For example, as shown in Figure 6, the top 3 may be constituted by a generally hemispherical or conical cap with external radial ribs having internal recesses 28, 29, 30, 31, 32, 33, 34 which extend radially from the collar 12 connecting to the hatch 4 as far as the peripheral flange 7 or a certain distance towards it.

In this embodiment, the collar 12 also forms an annular seal housing with a discontinuous outer edge which is interrupted by the cavities of the ribs and is intended to bear on the upper cap-like end of the tank. Large portions of the sectors, if not the entire sectors 36, 37, 38, 39, 40 of the top between the ribs, also bear on the tank.

The heights of the ribs advantageously decrease from the collar towards the periphery of the top in dependence on the local distance of the top from the upper cap of the tank.

The widths of the ribs may also vary, increasing from the collar towards the periphery of the top, so that each allows a wider arc and sector of the cylindrical wall of the tank and of its end caps to be investigated.

The behaviour of this top under stress is similar to that already described with the further advantage of offering greater resistance to any localized stresses exerted by the ground.

Claims

1. An improved, fluid-tight, openable, protective container of plastics material for the underground installation of a tank (14) of pressurized, liquefied gas, comprising a vessel with a generally cylindrical peripheral wall (1) closed at the bottom by a base (2) and at the top by a removable dome-shaped top (3) having a hatch (4) closed by an openable cover (5), for housing a tank (14) of liquefied gas with the formation of an interspace (17) between the container and the tank, the interspace being isolated from the space inside the hatch (4) by an annular seal (13) housed in a semitoroidal housing formed in a collar (12) connecting the top (3) and the hatch (4), the seal (13) being interposed under sealing compression between the collar (12) and the tank (14), characterized in that:
the semitoroidal housing has an outer edge (18) by which the top (3) bears on the tank (14) and an inner edge (20) which is spaced from the tank (14) and forms a calibrated opening (H1) between the inner edge (20) and the surface (19) of the tank (14) so that the seal (13) in the housing develops fluid-tightness at differentiated pressures, the pressure being higher in the case of excess pressure in the space inside the hatch (4) compared with the pressure in the interspace (17) and lower in the case of excess pressure in the interspace (17) compared with the pressure in the space inside the hatch (4).

2. A protective container according to Claim 1, in which the outer edge of the housing has at least one radial channel (21), closed by the seal (13), for communication between the interspace (17) and the space inside the hatch (4) so that an inspection and/or drainage probe can be inserted into the interspace (17) through the channel (21) solely by the removal of the seal (13), possibly even locally.

3. A protective container according to Claim 2, in which the outer edge (18) of the housing has a plurality of channels (21, 22, 23, 24, 25, 26, 27) extending radially from the collar (12).

4. A protective container according to Claim 1, in which the removable top (3) has a plurality of hollow recesses (28, 29, 30, 31, 32, 33, 34) extending radially from the collar (12) towards the periphery (7) of the top (3) which is connected to the cylindrical peripheral wall (1).

5. A protective container according to Claim 4, in which the heights of the ribs (28, ... 34) decrease from the collar (12) towards the periphery (7) of the top (3).

6. A protective container according to Claim 3, in which the widths of the ribs (28, ... 34) increase from the collar (12) towards the periphery (7) of the top (3).

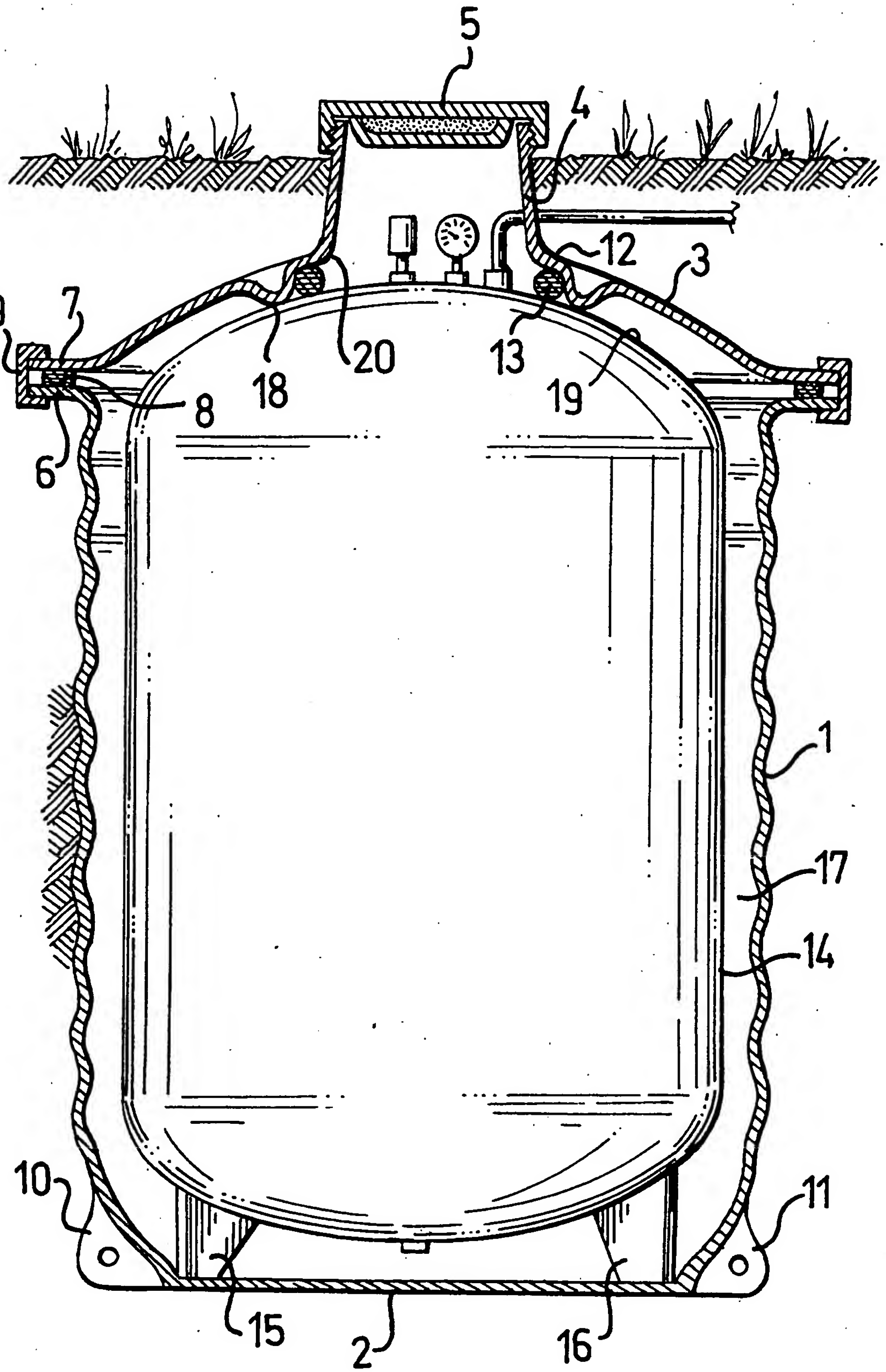

FIG.1

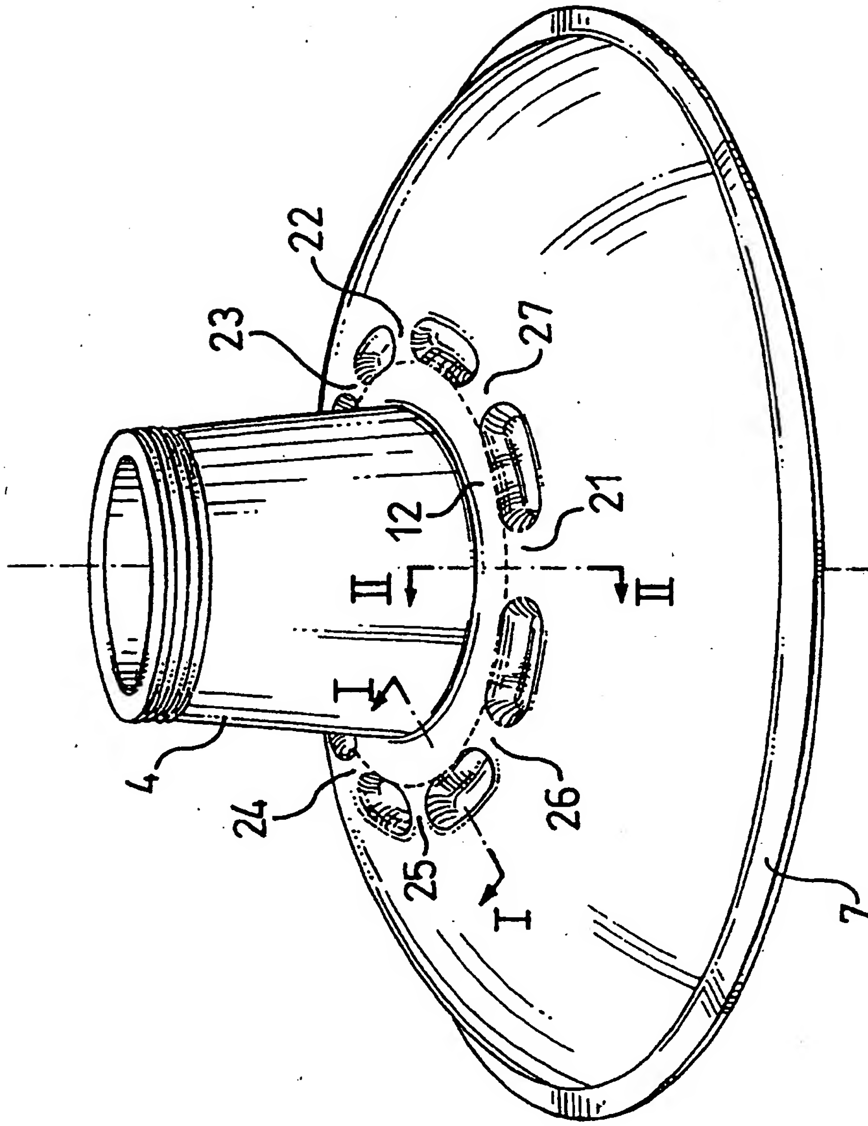

FIG.2

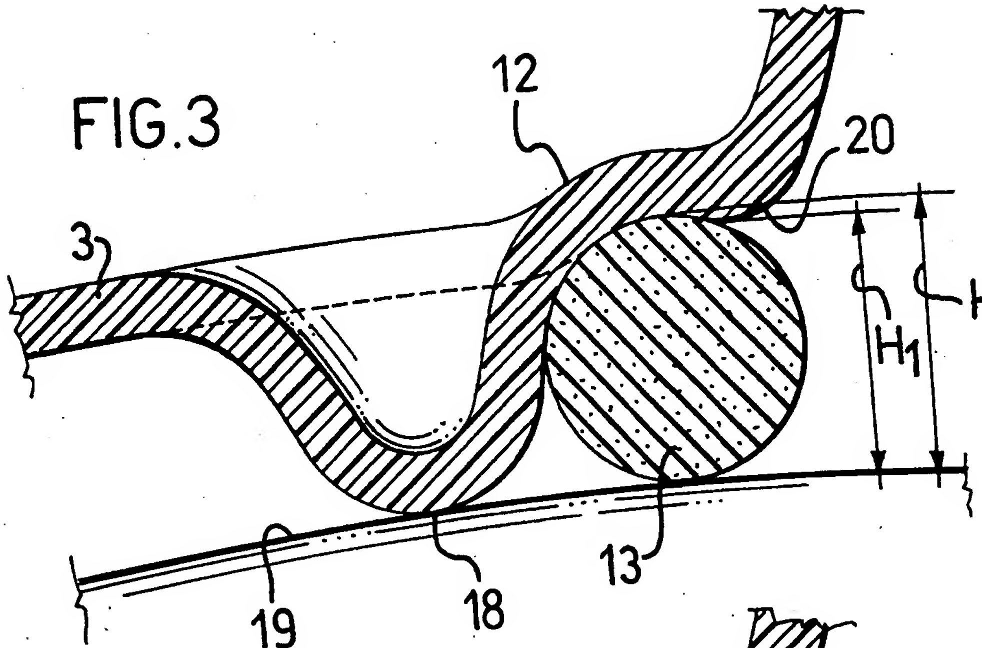

FIG.3

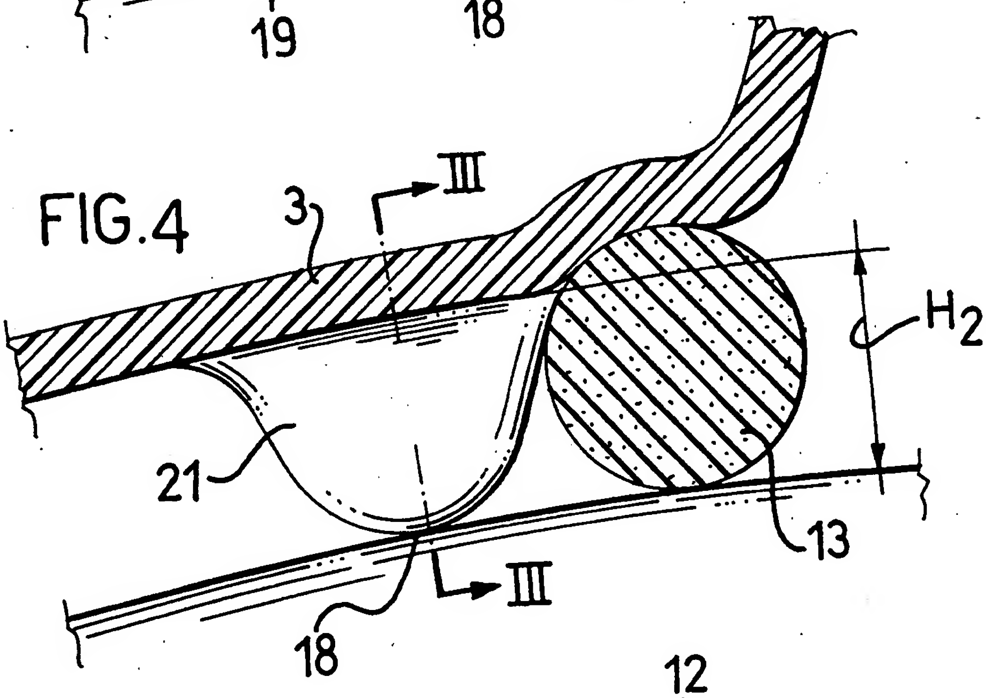

FIG.4

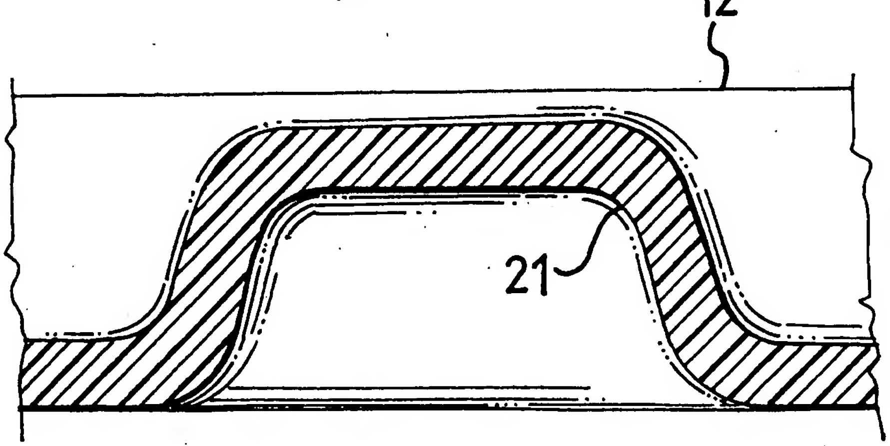

FIG.5

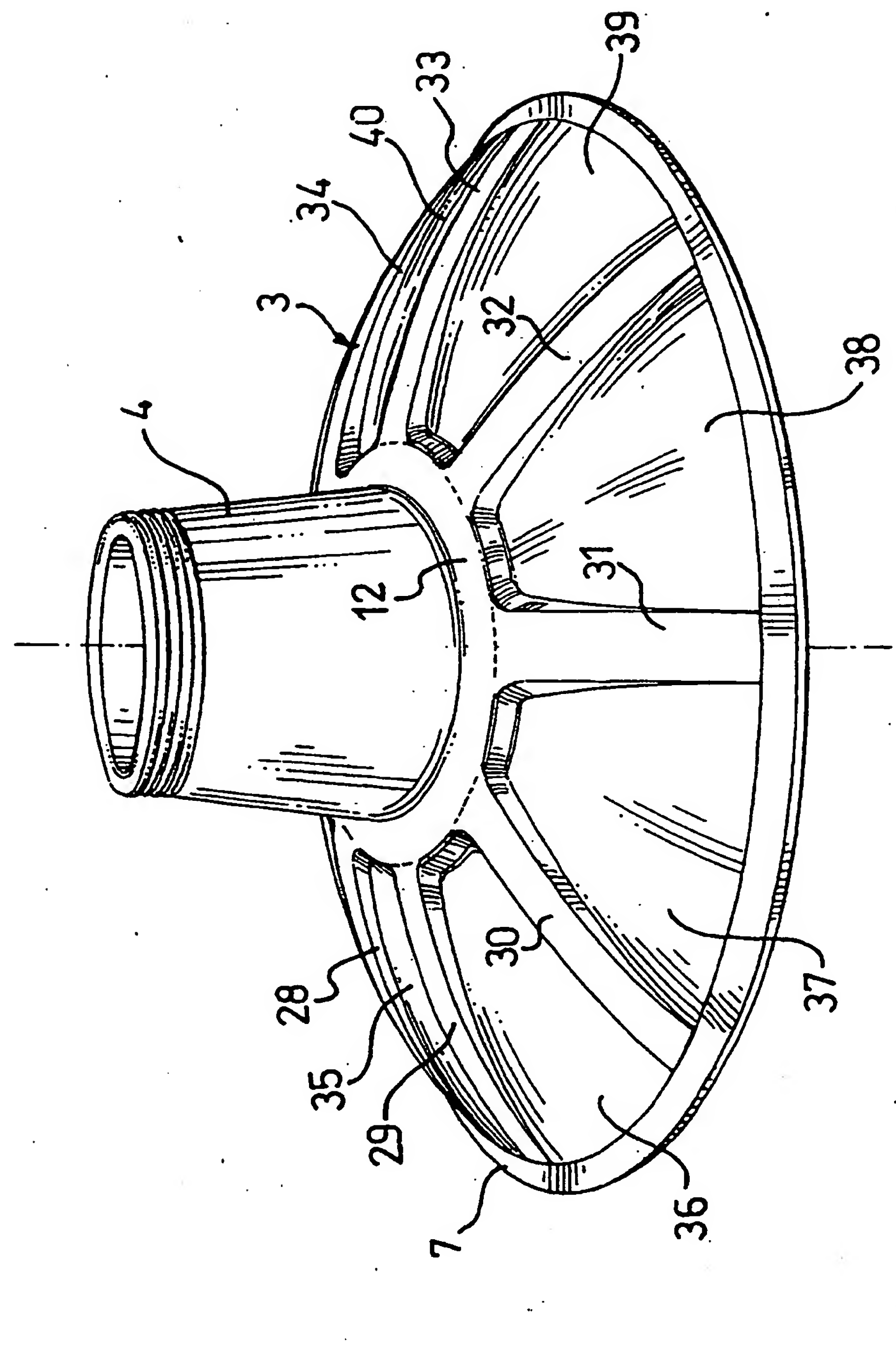

FIG.6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 83 0293

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A,D	EP-A-0 624 752 (WALTER TOSTO SERBATOI) -----		F17C1/00 F17C13/12
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F17C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 November 1995	Meertens, J

CATEGORY OF CITED DOCUMENTS

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